

CLAIMS

1. An optical signal processor for transforming a first vector into a second vector comprising:

5 a plurality of linear light sources each of which provides light having an intensity responsive to a different component of the first vector;

a spatial light modulator comprising a plurality of modulation zones each of which zones receives light from substantially only one of the light sources and transmits light in proportion to a transmittance that characterizes the modulation zone; and

10 at least one light detector for each component of the second vector that receives light transmitted from a plurality of modulation zones, each of which is illuminated by light from a different light source, and generates a signal responsive to the received light that represents a component of the second vector.

15 2. An optical processor according to claim 1 wherein the modulation zones are configured in an array of columns and rows of modulation zones.

3. An optical processor according to claim 2 wherein the array of modulation zones is a rectangular array.

20 4. An optical processor according to claim 2 or claim 3 wherein all the modulation zones in a same column of modulation zones are illuminated by light from a same light source.

25 5. An optical processor according to claim 4 wherein the at least one detector for each second vector component receives light transmitted from all the modulation zones in a different one of the rows of modulation zones.

30 6. An optical processor according to claim 5 wherein the at least one detector for each row of modulation zones has an aperture for collecting light that has a shape and size substantially equal to the shape and size respectively of the row of modulation zones from which it receives light.

7. An optical processor according to claim 6 wherein the aperture is contiguous with the row of modulation zones.

8. An optical processor according to any of claims 5-7 wherein efficiency of light transfer between a light source and a light detector for light at a wavelength that characterizes light provided by the light sources is less than a predetermined threshold efficiency ϵ that satisfies a relation $\epsilon^2 \leq 4/(N^3 \times \text{SNR})$ where N is a number of the plurality of light sources and SNR is a desired signal to noise ratio resulting from crosstalk.

9. An optical processor according to claim 5 and comprising optics that receives light transmitted from all the modulation zones in the spatial light modulator and images light from all modulation zones in each row of modulation zones to the row's at least one detector.

10. An optical processor according to claim 9 wherein the optics comprises a cylindrical lens that receives light transmitted from all the modulation zones and has its focal line substantially parallel to the rows of modulation zones and wherein the at least one light detectors for the modulation zone rows are positioned in a linear array perpendicular to the focal line so that light received from the modulation zones in a same row of modulation zones is imaged on a same one of the at least one light detectors.

11. An optical processor according to claim 5 and comprising a different collecting light pipe for each row of modulation zones in the spatial light modulator that receives light transmitted from the modulation zones in the row of modulation zones and pipes the received light and/or light generated in the light pipe responsive to the received light to the at least one light detector for the row of modulation zones.

12. An optical processor according to any of claims 11 wherein efficiency of light transfer between a light source and a light detector for light at a wavelength that characterizes light provided by the light sources is less than a predetermined threshold efficiency ϵ that satisfies a relation $\epsilon^2 \leq 4/(N^3 \times \text{SNR})$ where N is a number of the plurality of light sources and SNR is a desired signal to noise ratio resulting from crosstalk.

13. An optical processor according to claim 11 or claim 12 wherein light provided by the light sources is characterized by a first wavelength and the collecting light pipes are provided

with wavelength converters that convert light received by the light pipes from the modulation zones to light characterized by a second wavelength.

14. An optical processor according to claim 13 wherein the second wavelength is longer
5 than the first wavelength.

15. An optical processor according to claim 13 or claim 14 wherein surface areas of the light pipe are coated with a coating that transmits light at the first wavelength and is highly reflective for light at the second wavelength.

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16. An optical processor according to any of claims 11-15 wherein the collecting light pipe is a linear light pipe having two end surfaces and a light collecting surface that is a longitudinal surface region of the light pipe through which surface region light transmitted from the modulation zones in the row of modulation zones enters the light pipe.

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17. An optical processor according to claim 13 wherein the light pipe is a rectangular solid having four rectangular side surfaces, one of which side surfaces is the light collecting surface.

18. An optical processor according to claim 17 wherein the light collecting surface has a shape and size substantially the same as the shape and size of the area of the row of modulation zones from which it collects light.

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19. An optical processor according to claim 17 or claim 18 wherein the light collecting surface is contiguous with the row of modulation zones from which the light pipe collects light.

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20. An optical processor according to any of claims 16-19 wherein the at least one light detector for a second vector component comprises a single light detector that is coupled to an end surface of the collecting light pipe.

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21. An optical processor according to any of claims 16-19 wherein the at least one light detector comprises a light detector coupled to each end surface of the collecting light pipe.

22. An optical processor according to any of claims 1-21 wherein the relative amounts of light provided by any two light sources of the plurality of light sources for components of the first vector having a same value are adjusted so that a difference in an amount of light transmitted from the light sources through modulation zones having a same transmittance that reaches the at least one detector for each of the modulation zones is reduced.

23. An optical processor according to any of claims 1-22 wherein desired transmittances of modulation zones illuminated by a same light source are adjusted to compensate for differences in intensity of light along the length of the of the light source that illuminates the modulation zones.

24. An optical processor according to any of claims 1-23 wherein a ratio of areas of any two modulation zones illuminated by a same light source is substantially inversely proportional to the relative amounts of light that the modulation zones receive from the light source.

25. An optical processor according to any of claims 1-24 wherein the relative sensitivities of any two first and second at least one detectors are adjusted to reduce a difference in output signals that they provide when they receive light from modulation zones having a same transmittance that are illuminated by a same light source.

26. An optical processor according to any of claims 1-25 wherein the transmittance of each modulation zone in the spatial light modulator is fixed.

27. An optical processor according to any of claims 1-26 wherein the transmittance of each modulation zone in the spatial light modulator is controllable.

28. An optical signal processor according to any of claims 1-27 wherein each of the at least one light sources comprises a source light pipe that provides light from a longitudinal surface thereof to illuminate modulation zones of the spatial light modulator.

29. An optical signal processor according to claim 28 and comprising a light emitter coupled to an end surface of the source light pipe that illuminates the end surface with intensity of light responsive to a component of the first vector.
- 5 30. An optical signal processor according to claim 29 wherein the source light pipe is provided with light scattering elements.
31. An optical signal processor according to claim 30 wherein the density of the particles increases with distance from the end surface so as to improve uniformity of intensity of light
10 exiting the longitudinal surface as a function of distance from the end surface.
32. An optical signal processor according to any of claims 1-27 wherein the light source is formed from a material that exhibits luminescence.
- 15 33. An optical processor according to claim 32 and comprising a light emitter that illuminates the luminescent material to excite luminescence therein having intensity responsive to a component of the first vector.
34. An optical processor according to claim 32 and comprising a source of
20 electromagnetic field that generates an electromagnetic field in the luminescent material to excite luminescence therein having intensity responsive to a component of the first vector.
35. An optical signal processor according to any of claims 1-27 wherein each of the at least one light source comprises a linear fluorescent light emitter.
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36. A method for transforming a first vector into a second vector comprising:
representing each component of the first vector by intensity of light provided by a linear light source;
transmitting light from each light source through a plurality of modulation zones each
30 of which transmits light in proportion to a transmittance that characterizes the modulation zone; and

using light transmitted by all the modulation zones to generate a plurality of signals, each of which represents a different component of the second vector and wherein each signal is responsive to light transmitted by at least one of the modulation zones.

5 37. A method according to claim 36 wherein and no two signals are responsive to light transmitted by a same modulation zone.

38. A method according to claim 36 or claim 37 wherein no signal is responsive to light from more than one modulation zone illuminated with light from a same light source.

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39. A method according to any of claims 36-38 wherein each light source illuminates a same number of modulation zones.

15 40. A method according to any of claims 36-39 wherein each signal is substantially proportional to a total amount of light transmitted by all of the at least one of the modulation zones.

41. A method according to any of claims 36-40 wherein each signal is responsive to light transmitted by a plurality of the modulation zones.

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42. A method of propagating an optical signal in a light pipe, the method comprising:
generating an optical signal with light characterized by a first wavelength for which light is substantially not reflected at the surface of the light pipe;

25 of the light pipe so that it enters the light pipe; and

converting the first wavelength light that enters the light pipe to light characterized by a second wavelength that is highly reflected by the surface of the light pipe.

30 43. A method of preventing cross talk between first and second light pipes optically coupled at first and second optical junctions to a same third light pipe so as to input optical signals to the third light, the method comprising:

generating optical signals in the first and second light pipes that are input to the third light pipe with light characterized by a first wavelength for which light is transmitted at the first and second optical junctions;

5 converting the first wavelength light that enters the third light pipe to light characterized by a second wavelength that not transmitted through the first and second optical junctions.

44. A method according to claim 43 wherein the second wavelength light is reflected at each of the first and second optical junctions.

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45. A method according to claim 43 or claim 44 wherein the second wavelength light is absorbed at or in the vicinities of the first and second optical junctions.